# NPSBN – Capacity and Priority Management Overview

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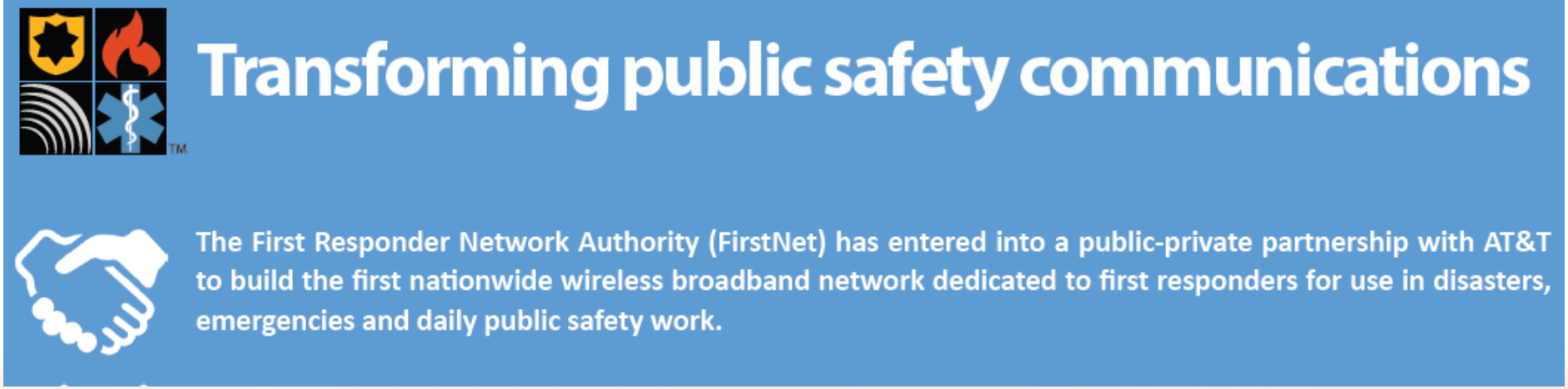
# Topics

- Background, Definitions & Objectives
- Congestion Situations
- LTE Quality of Service (QoS), Priority and Preemption ("QPP")
- Network States & Dynamic Controls
- *Responder Emergency* & *Immediate Peril* Definitions
- Examining QPP in State Plan Review

# Background

- FirstNet will deploy network on licensed spectrum (Band 14)
- AT&T is the chosen partner and will be allowed to let commercial users on Band 14 but must provide priority and preemption for public safety
- AT&T will also make use of its existing spectrum while Band 14 is being built out
  - QoS, Priority and Preemption may differ on AT&T system



# FirstNet RFP Objective #10

Provide a solution that allows the assignment of quality of service, priority, and preemption (QPP) parameters to user profiles using the standard service control parameters defined by 3GPP and the Internet Engineering Task Force, including Access Class, Quality Class Indicator (QCI), Allocation and Retention Priority (ARP), and Differentiated Service (Diff Serve).

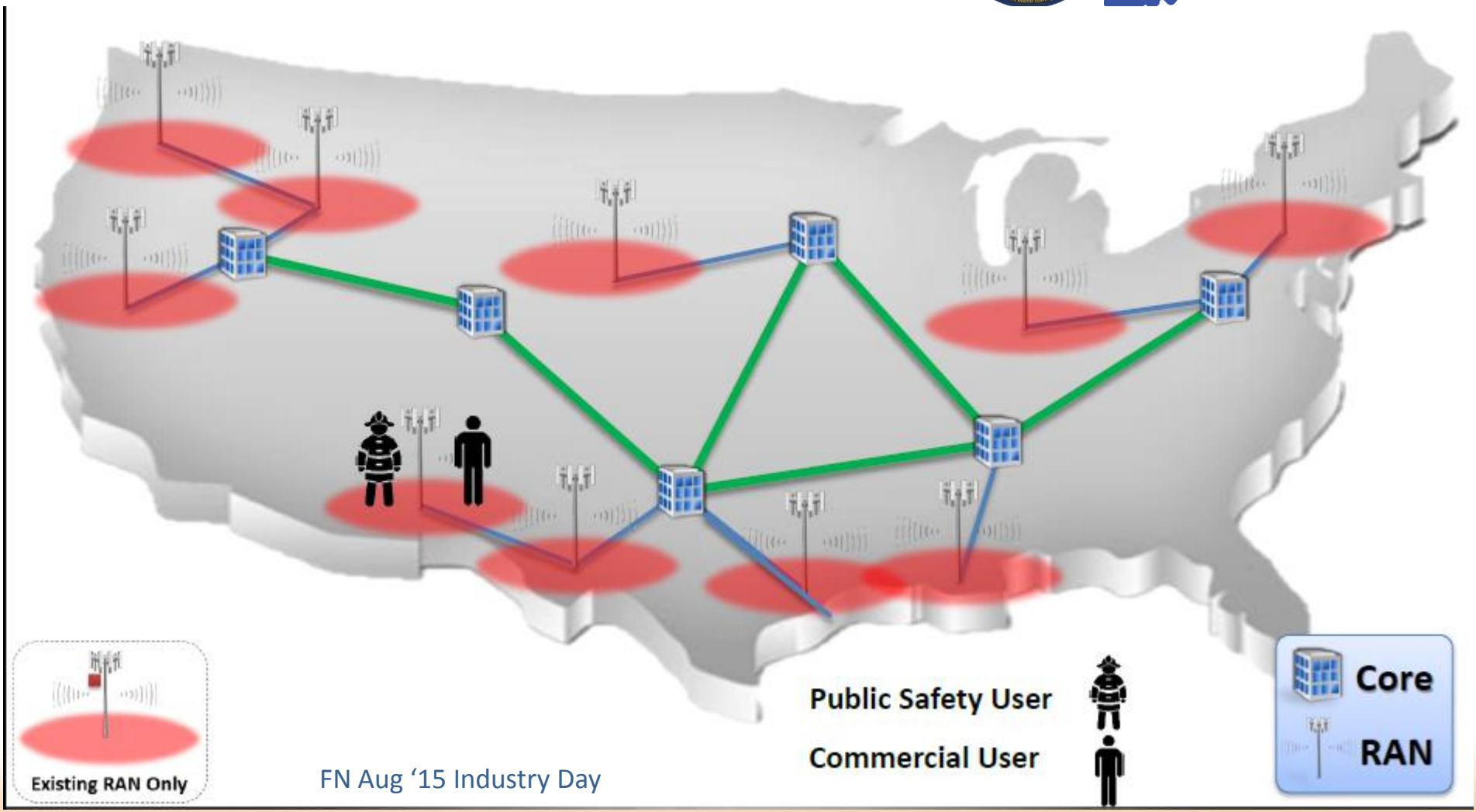
Allow control and management of static and dynamic assigned QPP parameters for public safety users and the ability to change user profiles in real time in response to incidents. User profile assignments and changes should be managed locally by PSEs.


# Definitions

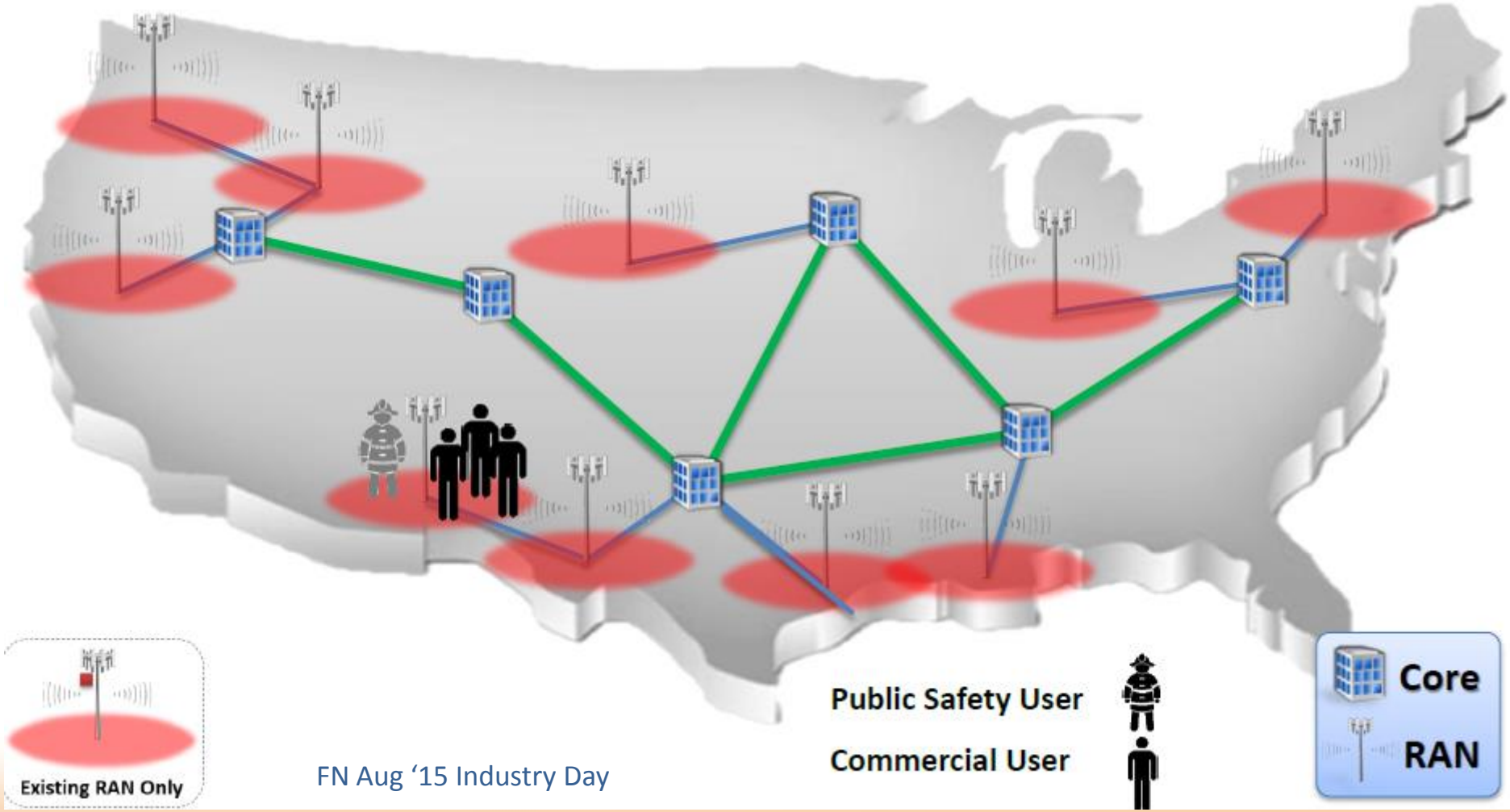
- **Quality of Service (QoS), Priority, and Preemption** (aka QPP) - key concepts for public safety operation on the NPSBN.
- **QoS:** QoS mechanisms allow network operators to differentiate and control the performance experienced by certain groups.[1]
- **Priority**: Priority is a network capability that enables a user's application or usage of the network to take precedence over another user's application or usage of the network.
- **Preemption**: A network capability that permits authorized high priority traffic to take over resources assigned to lower priority traffic.

1 – Olsson, *EPC and 4G Packet Networks*, 2nd Edition, Academic Press, Chapter 8 intro.

# Situation Today

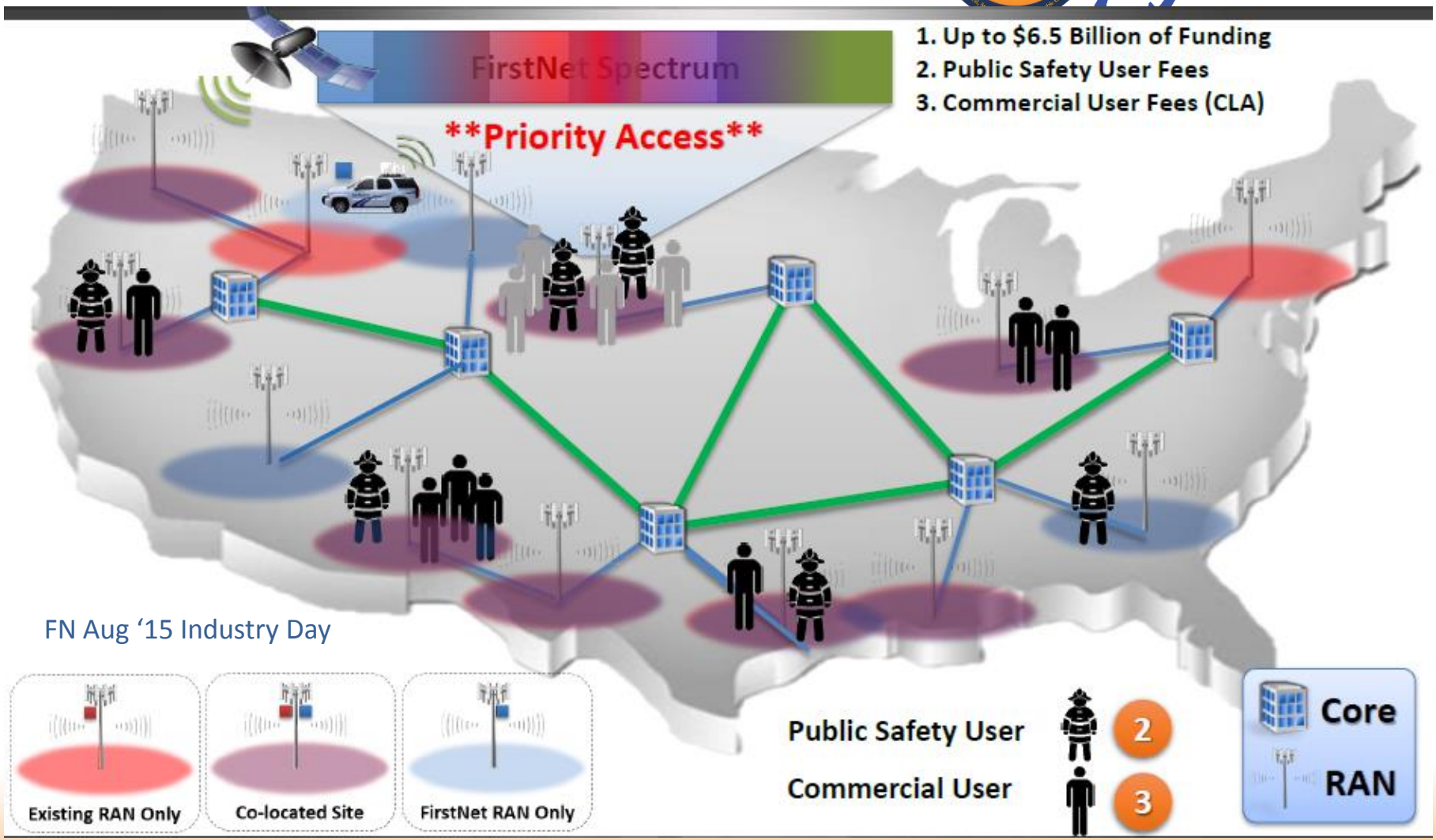


# Congestion Today




FN Aug ‘15 Industry Day

# Future NPSBN



# LTE and QPP

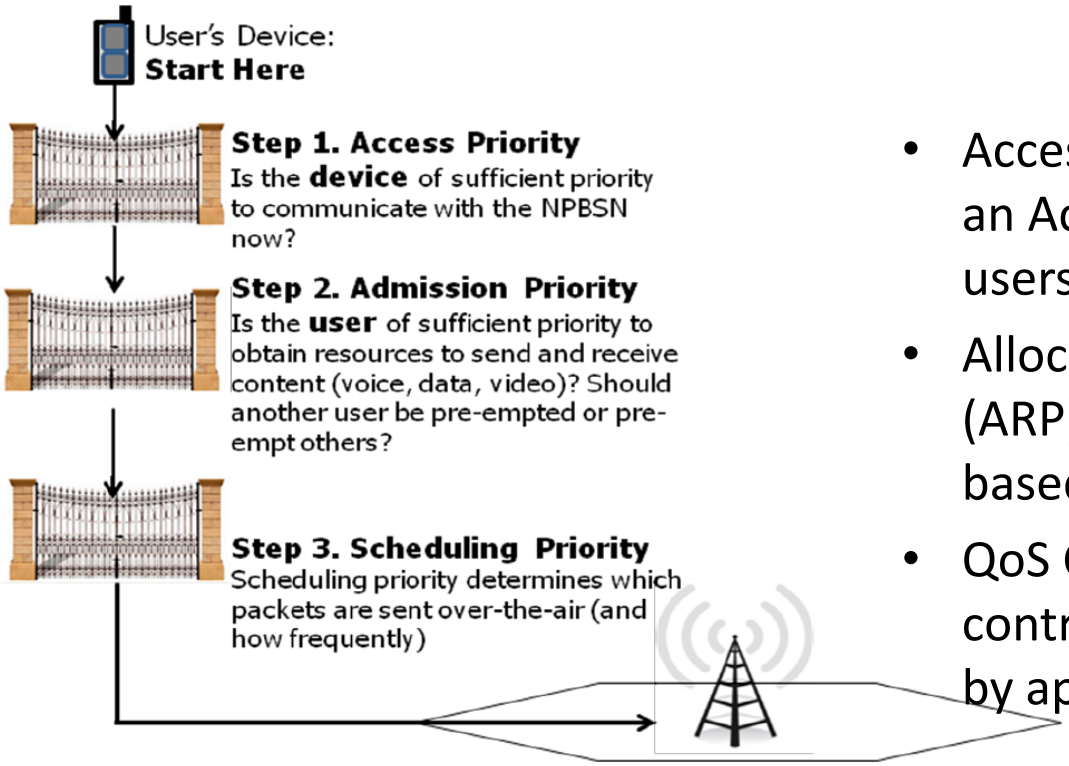



FIGURE 4. LTE PRIORITIZATION "GATES"

NPSTC Priority and QoS Working Group

- Access Class: Every device is assigned an Access Class – Emergency Services users will be assigned a higher AC
- Allocation and Retention Priority (ARP): Used to control preemption, based on user and application
- QoS Class Identifiers (QCIs): Used to control packet and scheduling priority by application

LTE has inherent QPP controls

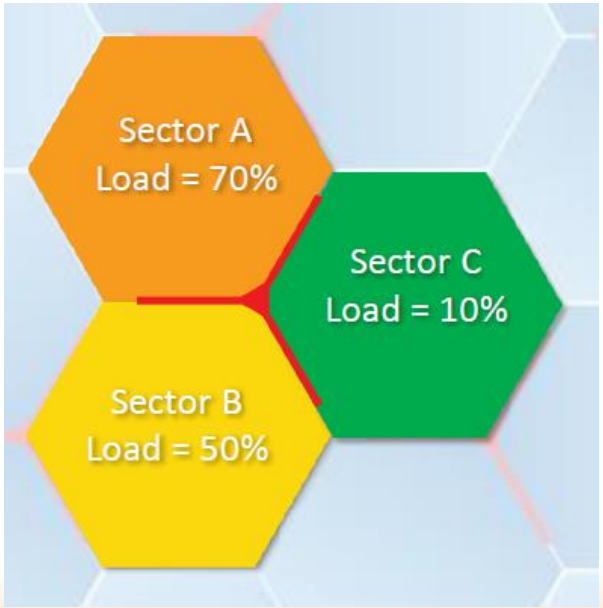
# Congestion and the Network

- Congestion can impair a user's experience such as slow application response, delayed downloads, choppy video, Etc.
- Congestion can occur in various portions of the network
- The air interface to the user device is the most likely cause of congestion
  - The NPSBN's assigned spectrum provides a theoretical maximum bit rate of 74Mbps in the downlink and 36Mbps in the uplink.
  - This capacity is shared by all users using that spectrum on that site/sector
  - Capacity to a given device is greatly dependent on the user's distance from the site - Users at the cell edge will reduce the overall capacity
- Congestion may also occur on the backhaul network
  - This form of congestion is broader and may affect a larger number of users

*QPP only comes into play when the network is congested.*

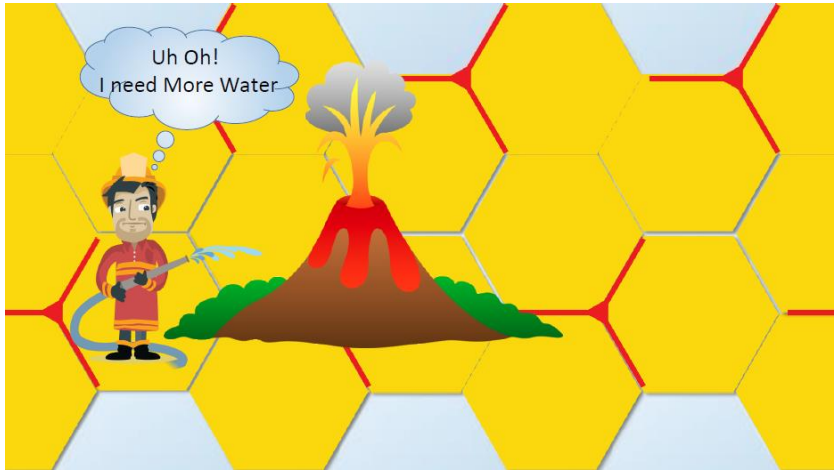
# Congestion Examples

- Capacity and congestion over the air can be very localized
  - Each cell sector may be operating at different capacity/loading
  - One site/sector could be strained or congested by an incident while an adjacent site could have nearly full capacity




# Backhaul Priority

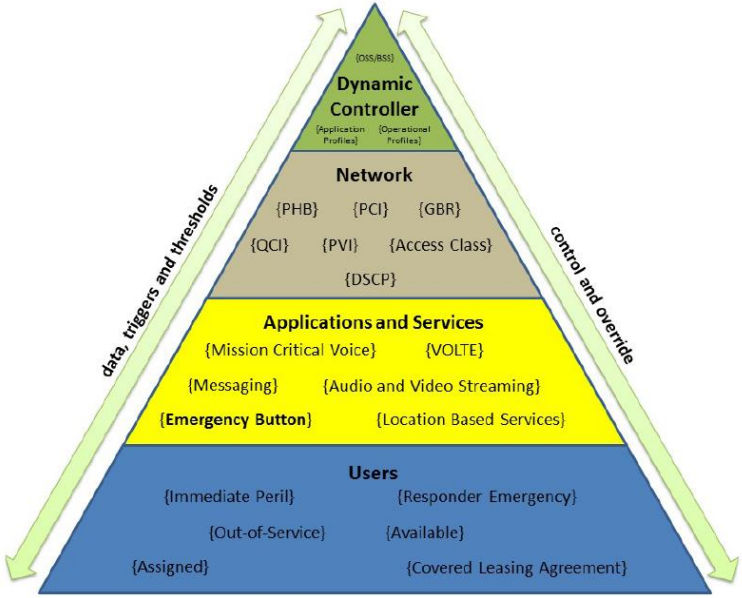
- QoS and Priority capabilities can also be established in the backhaul network using features such as Differentiated Services (Diff Serve) and IP – MPLS (Multi-Protocol Layer Switching)
- Mapping must be done between the air interface and backhaul QoS parameters




FN QPP Intro

# A Model for QPP

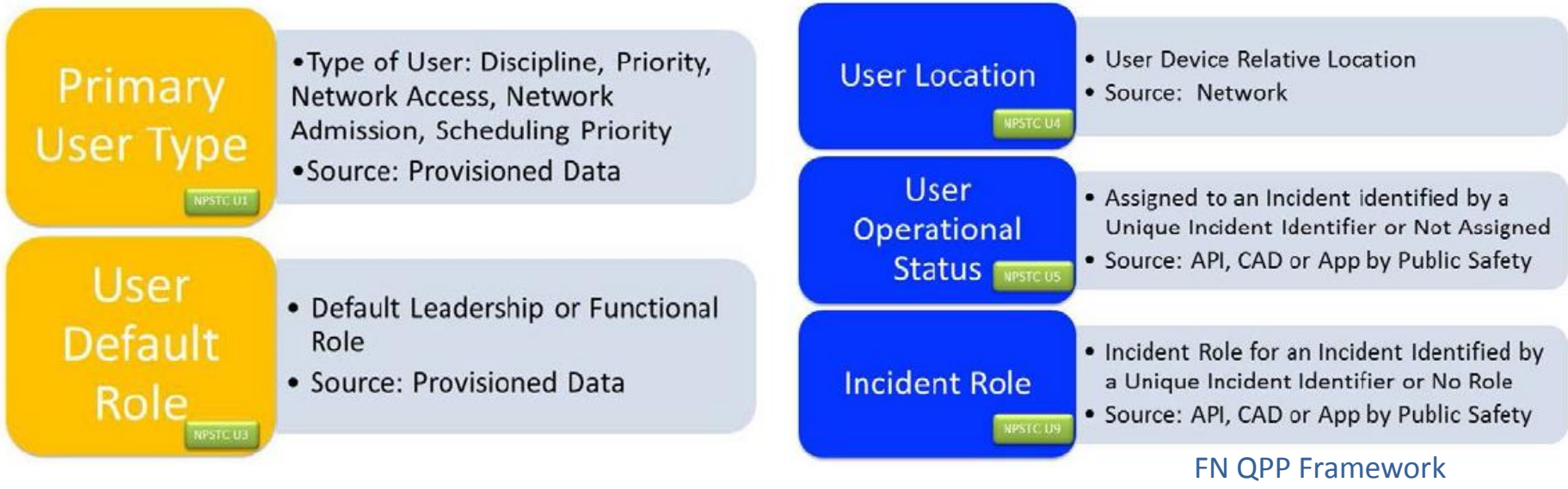
- QPP parameters will be defined to control QoS, Priority and Preemption for public safety users
  - Type of user
    - Static
    - Dynamic (operational)
  - Incident data
  - Application data
    - Static
    - Dynamic (operational)




FN CTO Whitepaper - QPP

*The goal is for QPP to work with minimal End User intervention.*

# User Types



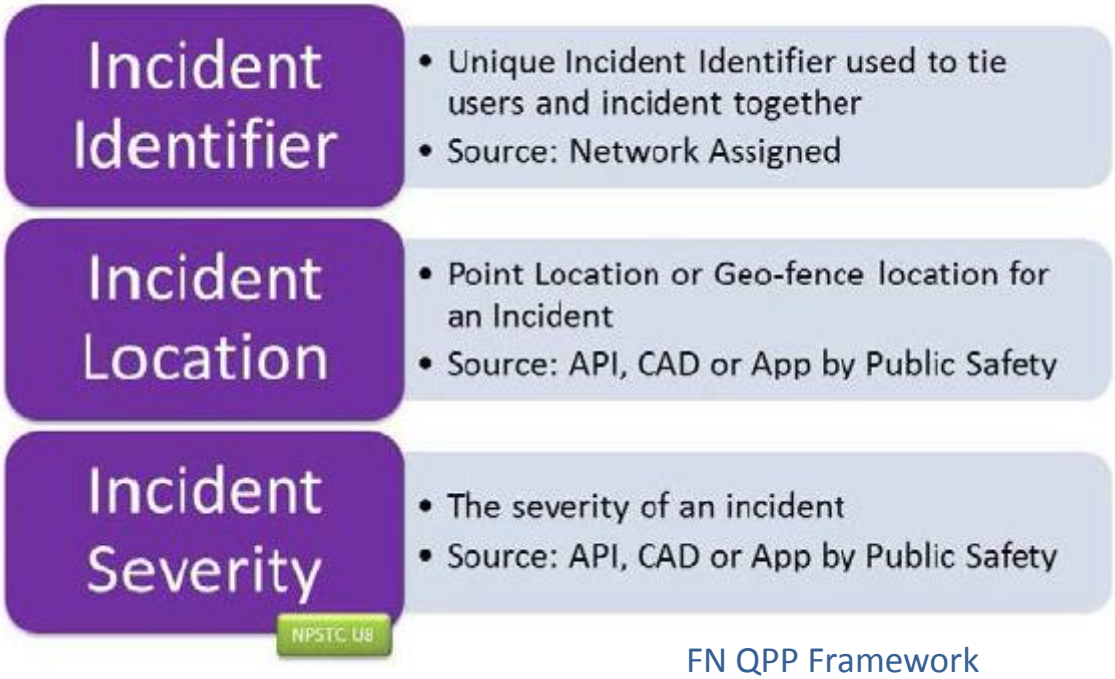

Static Data

Dynamic Data

*Static data will be established at provisioning.*

*Dynamic data can be adjusted in real time.*

# Incident Type




FN QPP Framework

*Incident data will be adjusted in real time by the network and/or a Public Safety application*

# Application Type

| | |
|---|---|
| Type | •Major Application Type: Incident Command, Voice, Messaging, 911, Applications, Machine-to-Machine, Video, Responder Safety and Off-Net |
| Usage Scenario | • One of approximately 40 Predefined usage scenarios |
| Priority | •Priority Value for the application: High – Medium - Low |
| Quality | • Quality of Service (delay tolerance) for the Application: High - Medium - Low |
| Preemption | • Whether the Application can Preempt or be Preempted: Can Preempt - Can Be Preempted |
| Frequency of Use | • Expected frequency of use for the Application: Usage per Hour |
| Expected Bandwidth | • Expected or required bandwidth for the Application: in Kilobits per second |

FN QPP Framework

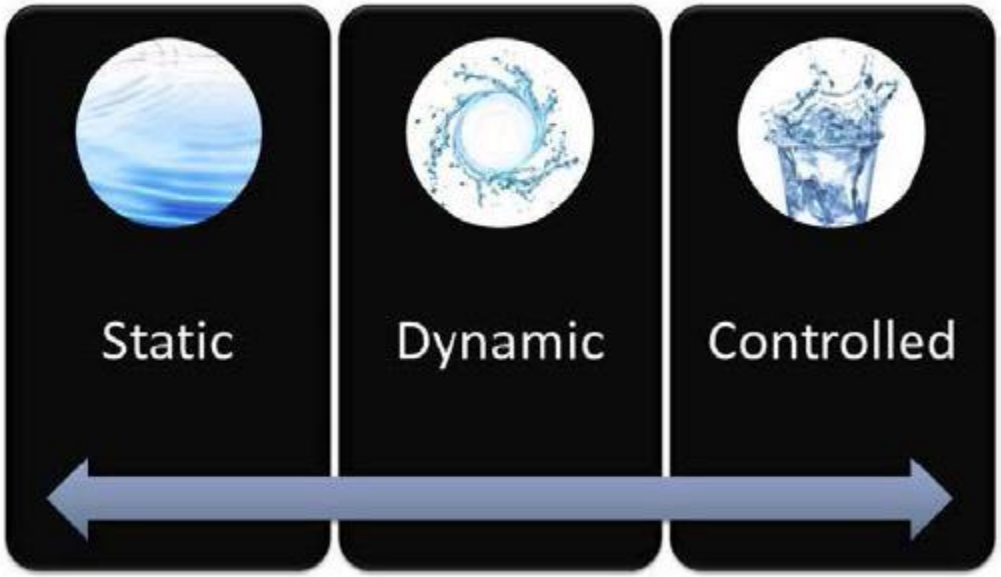
*This data is defined during agency onboarding.*

# Operational Profiles


FN QPP Framework

- Application Profiles can be grouped into Operational Profiles
- Public Safety Entities define their own Operational Profiles
- PSEs should be able to change their Operational Profile when they acquire an active role in an incident

# Network States

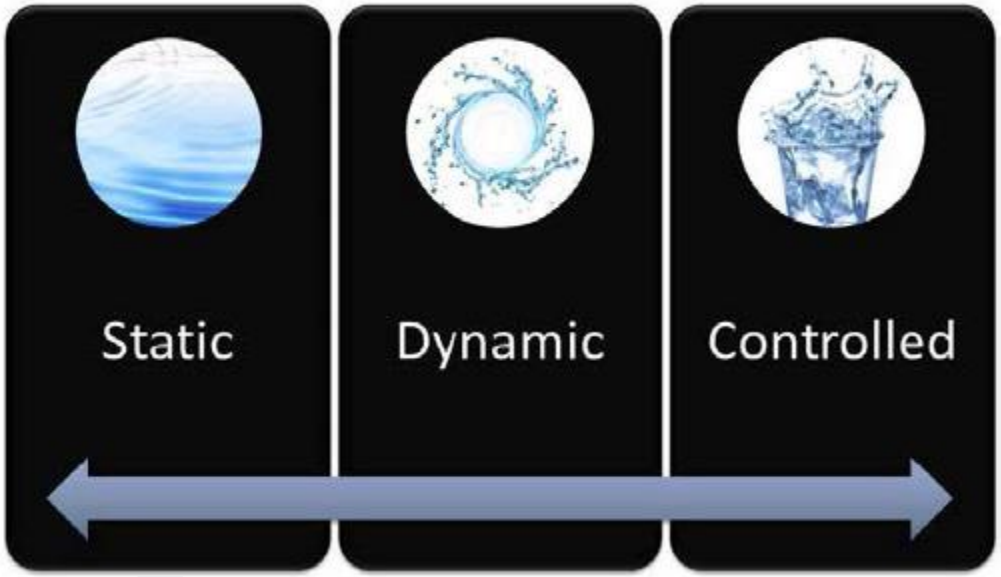



FN QPP Framework

*Static, Dynamic and Controlled states can coexist in the overall NPSBN, in different geographical areas.*

# Network State: Static

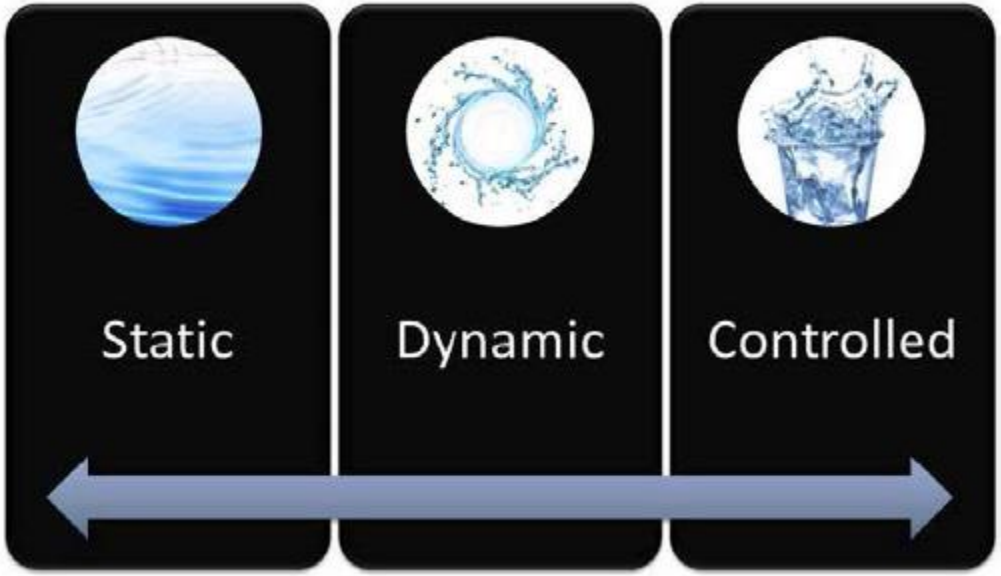
Most Common Operational Mode




FN QPP Framework

The network operational mode that utilizes the QoS, Priority and Preemption properties that were statically defined when users were provisioned in the network

# Network State: Dynamic



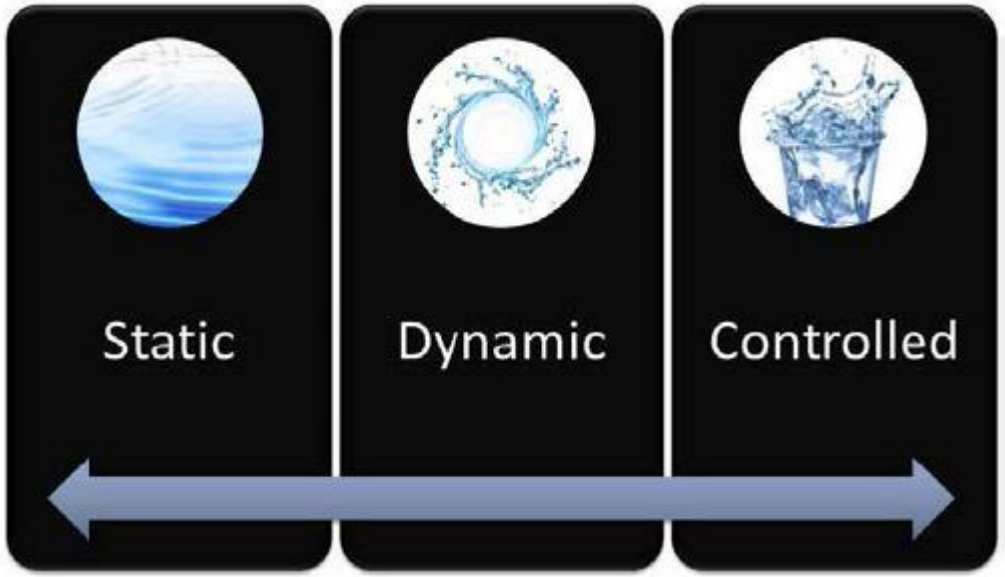

FN QPP Framework

Network Reacts to Environment

The network operational mode when the network begins to see congestion that cannot be relieved through the static QPP configuration utilized in the Static State.

# Network State: Controlled

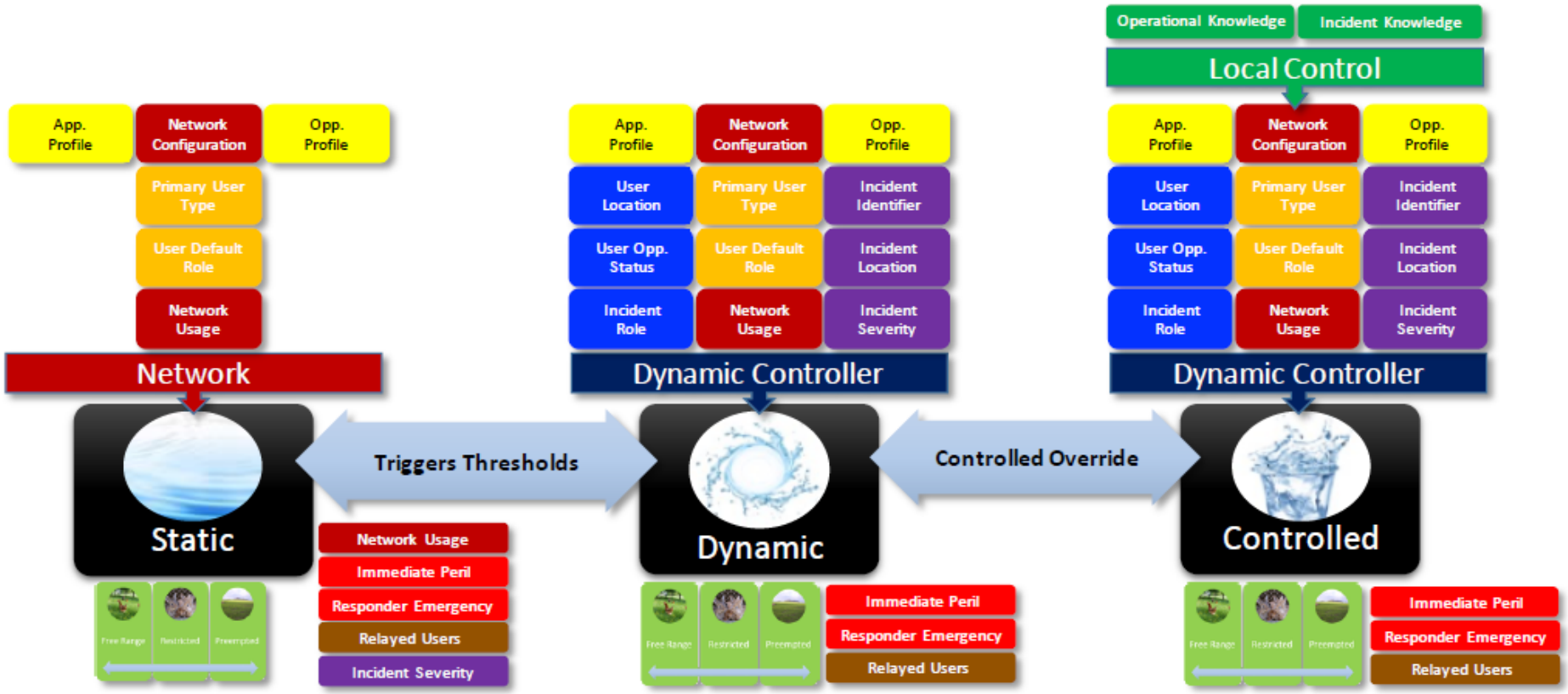
Network Accepts User Input




FN QPP Framework

The network operational mode when QPP properties can be directly influenced by an authorized individual

# Overall QPP Framework




FN QPP Framework

*A QPP framework plus Responder Emergency and Immediate Peril*

# Emergency, Immediate Peril

| Responder Emergency | Immediate Peril |
|---|---|
| Used by the public safety user when there is an immediate danger to their life or property | Used by the public safety user when there is an urgent need to access a particular broadband application that is being denied due to network congestion. The urgent need is tied to a threat to human life or property, not necessarily the responder themselves |
| Police Officer activates Responder Emergency after shots are fired | EMS technician activates IP to prioritize a telemedicine session for a patient he is treating |
| A remote video dispatcher sees a responder fall unconscious and activates RE for the downed User | In congestion, the Incident Commander wants to view video from a firefighter's body--worn camera |

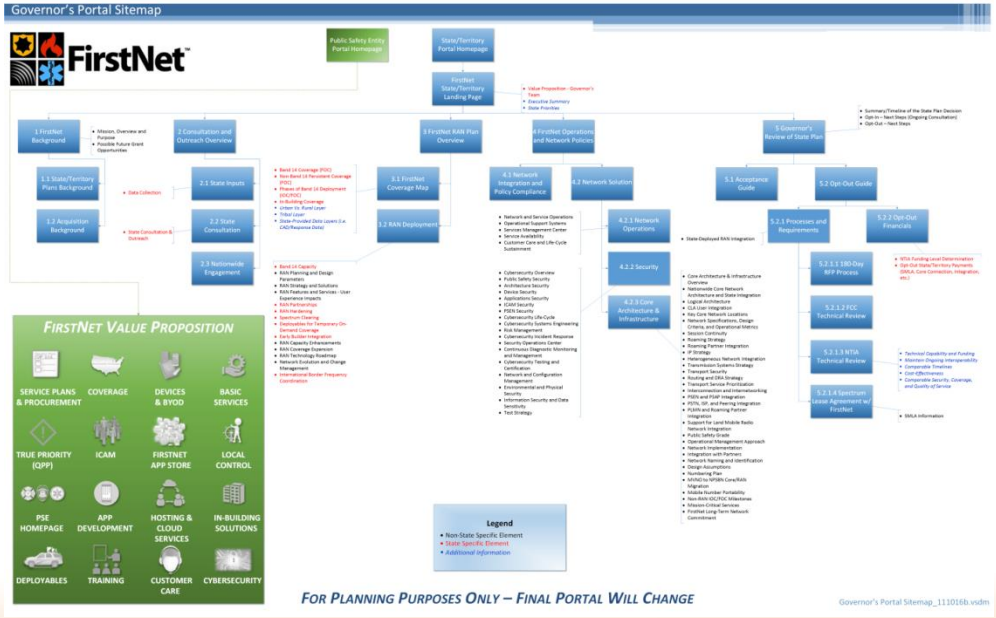
*Prioritized application for RE is set during provisioning, while it is chosen by the user for IP*

# Relationship to Local Control

- Set user parameters at the time of device partitioning
- Set application parameters at the time of agency on-boarding
- Set operational profiles at the time of agency on-boarding
- Users have access to Responder Emergency and Immediate Peril
- Adjust user and application profiles dynamically when necessary (on rare occasions)

# QPP in the State Plan

- How does the State Plan address RFP Objective #10 for QPP?
- Review Local Control descriptions:
- Key RF parameters (for instantaneous capacity)
- Tonnage (for overall network capacity)




FN Portal Concept

# QPP in the State Plan (Cont.)

- How does the State Plan address RFP Objective #10 for QPP?
  - Section A.6: Network Services
  - Operational differences?:
    - On existing AT&T network before Band 14 is built out;
    - Once Band 14 is built out and co-exists with AT&T commercial band;
    - In areas only with Band 14 coverage.

IOC/FOC (Attachment J-8 of RFP)

| | Timing/Area | IOC-1<br>6 months from award | IOC-2<br>12 months | IOC-3<br>24 months | IOC-4<br>36 months | IOC-5<br>48 months | FOC<br>60 months |
|---|---|---|---|---|---|---|---|
| G. | Coverage and Capacity Solutions (State and Territory Task Orders) | | • Achievement of 20% of Contractor's proposed Band 14 coverage in non-rural areas | • Achievement of 60% of Contractor's proposed Band 14 coverage in non-rural areas | • Achievement of 80% of Contractor's proposed Band 14 coverage in non-rural areas | • Achievement of 95% of Contractor's proposed Band 14 coverage in non-rural areas | • Achievement of 100% of Contractor's proposed Band 14 coverage in non-rural areas |
| H. | Substantial Rural Milestones (State and Territory Task Orders) | | • Achievement of 20% of Contractor's proposed Band 14 coverage in rural areas | • Achievement of 60% of Contractor's proposed Band 14 coverage in rural areas | • Achievement of 80% of Contractor's proposed Band 14 coverage in rural areas | • Achievement of 95% of Contractor's proposed Band 14 coverage in rural areas | • Achievement of 100% of Contractor's proposed Band 14 coverage in rural areas |

# QPP in the State Plan (Cont.)

- Review Local Control descriptions:
  - Provisioning Capability
    - Section B.7: Local Control and Management of User Devices;
    - Section C.5: Local Control (Applications);
  - Support of Responder Emergency and Immediate Peril
  - Opportunity for authorized users to make dynamic adjustments

State Plan Template (Attachment J-19 of RFP)

# QPP in the State Plan (Cont.)

- Key RF parameters (for instantaneous capacity)
  - The FirstNet RFP required respondents to provide information on average uplink and downlink data rates

| Number of sectors with Average DL sector throughput | | | | |
|---|---|---|---|---|
| < 10 Mbps | 10-16 Mbps | 16-22 Mbps | 22-28 Mbps | >28 Mbps |

| Number of sectors with Average UL sector throughput | | | | |
|---|---|---|---|---|
| < 7 Mbps | 7-11 Mbps | 12-18 Mbps | 19-25 Mbp | >25 Mbps |

Coverage and Capacity
(Attachment J-17 of RFP)

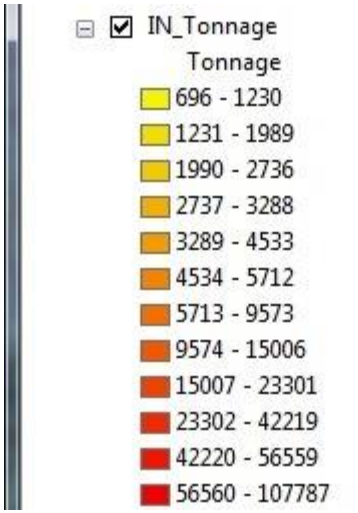
# QPP in the State Plan (Cont.)

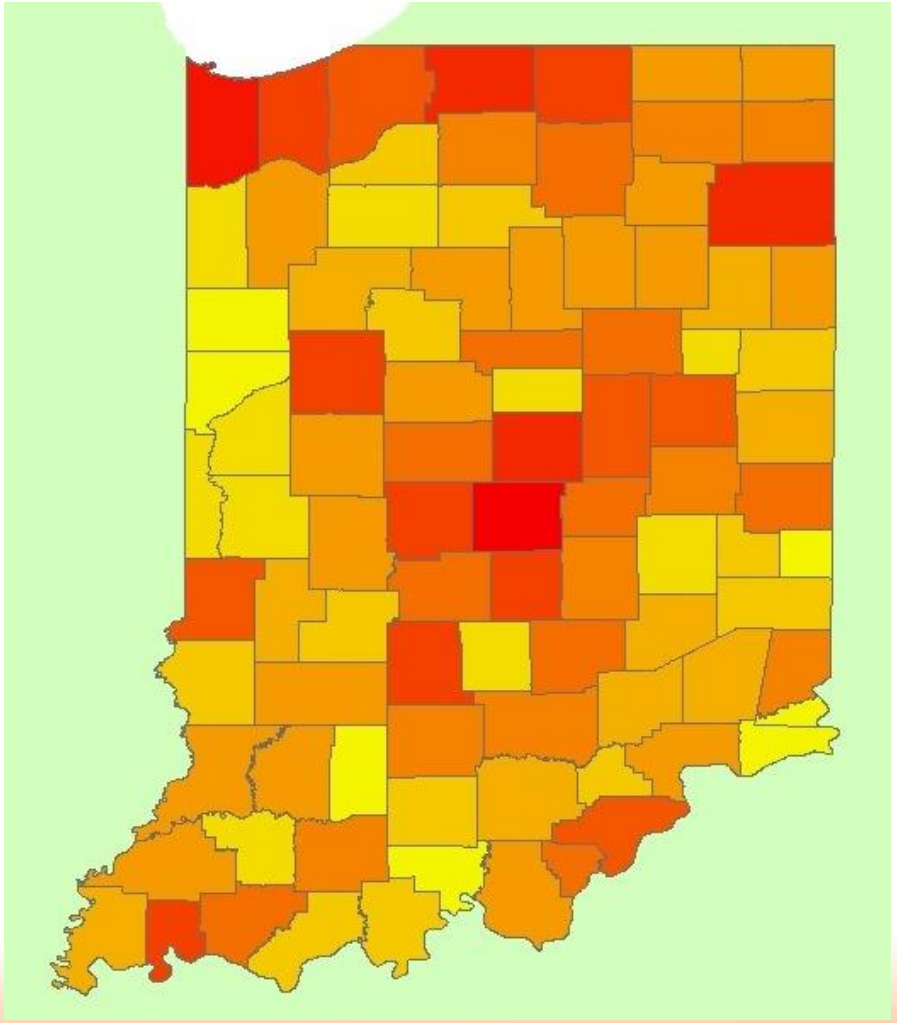
- Tonnage (for overall network capacity)
- Estimated county-by-county in GB/mo.
- Total estimated for IN is 761,122 GB/mo.
- Should be evaluated at different stages of deployment: IOC1-5, FOC
  - What is the growth factor?

| County Name | *Total Tonnage by County (GB/Month)* |
|---|---|
| Marion | 107,787 |
| Lake | 56,559 |
| Allen | 42,219 |
| Hamilton | 34,914 |
| St. Joseph | 30,876 |
| Elkhart | 23,301 |
| Tippecanoe | 21,123 |
| Vanderburgh | 21,000 |
| Porter | 19,275 |
| Hendricks | 18,006 |
| Johnson | 17,022 |
| Monroe | 16,539 |
| Madison | 15,006 |
| Delaware | 13,506 |
| Clark | 13,182 |
| LaPorte | 12,858 |
| Vigo | 12,480 |
| Howard | 9,573 |
| Bartholomew | 9,255 |
| Kosciusko | 9,063 |
| Floyd | 8,790 |
| Hancock | 8,304 |
| Morgan | 8,040 |
| Grant | 7,911 |
| Wayne | 7,809 |

Tonnage, User, Device from RFP

# FirstNet Tonnage Map



Graphical representation of Tonnage from RFP

# Conclusion and Next Steps

- QPP is a key item for public safety use of the NPSBN
  - There are complex underlying technical parameters that control QPP
  - The goal of the FirstNet QPP framework is to work effectively for public safety with minimal End User intervention
- Prepare for Draft State Plan review:
  - Identify State team to review current QPP information:
    - Distribute briefing package to review team
    - Become familiar with the proposed framework
  - Review State Plan guidance from FirstNet and update plan as necessary
  - Review and validate the Tonnage map
    - Estimate current usage
  - Identify additional information to be gathered

# Q&A - Discussion



# *Thank You!*

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